

WHAT IS CLAIMED IS:

1. A thin film magnetic head with a write element, the write element comprising a lower yoke, a lower pole, an upper yoke, an upper pole, a gap film, a lower coil, and an upper coil, wherein:

5 the lower pole projects from one surface of the lower yoke at a medium-facing surface side;

the upper yoke is disposed at a distance from the lower yoke and is connected to the lower yoke by a back gap portion that is recessed in the thin film magnetic head from the medium-facing surface;

10 the upper pole is adjacent to the gap film, faces the lower pole with the gap film interposed between the lower pole and the upper pole, and has the top surface adjacent to one surface of the upper yoke;

the lower coil surrounds in a spiral form the back gap portion, arranged within the height of the lower pole in relation to said one surface
15 of the lower yoke;

the upper coil is disposed above the lower coil, arranged within the height of the upper pole in relation to said one surface of the upper yoke, and surrounds in a spiral form the back gap portion; and

the gap film is at an intermediate level in the pole length that is
20 defined by the height of the lower pole and the height of the upper pole.

2. The thin film magnetic head of claim 1, wherein:

the lower coil comprises a first coil and a second coil;

the first and second coils surround in a spiral form the back gap

portion, and one of the first and second coils is fitted into the space between coil turns of the other, insulated from the coil turns of the other, and the first and second coils are connected to each other so as to generate magnetic flux in the same direction.

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3. The thin film magnetic head of claim 2, wherein:

the upper coil comprises a third coil and a fourth coil;

the third and fourth coils surround in a spiral form the back gap portion, and one of the third and fourth coils is fitted into the space between
10 coil turns of the other, insulated from the coil turns of the other, and the third and fourth coils are connected to each other so as to generate magnetic flux in the same direction and connected to the lower coil so as to generate magnetic flux in the same direction as the lower coil.

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4. The thin film magnetic head of claim 3, wherein the lower pole comprises:

a first lower pole film formed of the lower yoke;

a second lower pole film adjacent to the first lower pole film, having one surface flattened to the same level as the lower coil; and

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the other lower pole films disposed in order adjacently to one another on the second lower pole film, and each of said other lower pole films having one surface flattened to the same level as an insulating film disposed in the vicinity of this film, and the uppermost film of said other lower pole films being adjacent to the gap film.

5. The thin film magnetic head of claim 4, wherein the lower pole comprises:

a third lower pole film adjacent to the second lower pole film; and

5 a fourth lower pole film adjacent to the third lower pole film, being the uppermost film in the lower pole.

6. The thin film magnetic head of claim 5, wherein the upper pole comprises:

10 a plurality of upper pole films disposed in order adjacently to one another on the gap film, and the uppermost film of said plurality of upper pole films being adjacent to the upper yoke.

7. The thin film magnetic head of claim 6, wherein the upper pole comprises:

a first upper pole film adjacent to the gap film;

a second upper pole film adjacent to the first upper pole film; and

a third upper pole film adjacent to the second upper pole film.

20 8. The thin film magnetic head of claim 7, further comprising a coil-connecting conductor, wherein:

the coil-connecting conductor comprises:

a first connecting conductor film formed of the inner end of the first coil and having one surface flattened to the same level as the first

coil, the second coil and the second lower pole film;

5 a second connecting conductor film made of the same material as the first connecting conductor film, disposed on said one surface of the first connecting conductor film and having one surface flattened to the same level as the third lower pole film that is adjacent to the second lower pole film;

a third connecting conductor film adjacent to the second connecting conductor film;

10 a fourth connecting conductor film adjacent to the third connecting conductor film;

a fifth connecting conductor film adjacent to the fourth connecting conductor film; and

a sixth connecting conductor film adjacent to the fourth connecting conductor film; and

15 the back gap portion comprises:

a first back gap film made of the same material as the second lower pole film, disposed on said one surface of the lower yoke and having one surface flattened to the same level as the first coil, the second coil and the second lower pole film;

20 a second back gap film made of the same material as the third lower pole film, disposed on the second back gap film and having one surface flattened to the same level as the third lower pole film;

a third back gap film adjacent to the second back gap film;

a fourth back gap film adjacent to the third back gap film;

a fifth back gap film adjacent to the fourth back gap film; and
a sixth back gap film adjacent to the fifth back gap film.

9. The thin film magnetic head of claim 8, wherein:

5 the third lower pole film, the second connecting conductor film and
the second back gap film have surfaces flattened to the same level;

the fourth lower pole film, the third connecting conductor film and
the third back gap film have surfaces flattened to the same level;

10 the first upper pole film, the fourth connecting conductor film and
the fourth back gap film have surfaces flattened to the same level;

the second upper pole film, the fifth connecting conductor film and
the fifth back gap film have surfaces flattened to the same level;

15 the third upper pole film, the sixth connecting conductor film and the
sixth back gap film have surfaces flattened to the same level as the top
surfaces of the third and fourth coils;

the upper yoke has one end adjacent to the third upper pole film and
the other end adjacent to the sixth back gap film.

20 10. A magnetic recording/reproducing apparatus comprising a
thin film magnetic head and a magnetic recording medium, wherein:

the thin film magnetic head comprises a write element, the write
element comprising a lower yoke, a lower pole, an upper yoke, an upper
pole, a gap film, a lower coil, and an upper coil;

the lower yoke has one flat surface;

the lower pole projects from said one surface of the lower yoke at a medium-facing surface side and has a reduced track width at its upper end adjacent to the gap film;

5 the upper yoke is disposed at a distance from the lower yoke and is connected to the lower yoke by a back gap portion that is recessed in the thin film magnetic head from the medium-facing surface;

10 the upper pole is adjacent to the gap film, faces the upper end of the lower pole with the gap film interposed between the upper end of the lower pole and the upper pole, and has the top surface adjacent to one surface of the upper yoke;

the lower coil surrounds in a spiral form the back gap portion, arranged within the height of the lower pole in relation to said one surface of the lower yoke;

15 the upper coil is disposed above the lower coil, arranged within the height of the upper pole in relation to said one surface of the upper yoke, and surrounds in a spiral form the back gap portion; and

the gap film is at an intermediate level in the pole length that is defined by the height of the lower pole and the height of the upper pole.

20 11. The magnetic recording/reproducing apparatus of claim 10, wherein:

the lower coil comprises a first coil and a second coil;

the first and second coils surround in a spiral form the back gap portion, and one of the first and second coils is fitted into the space

between coil turns of the other, insulated from the coil turns of the other, and the first and second coils are connected to each other so as to generate magnetic flux in the same direction.

5 12. The magnetic recording/reproducing apparatus of claim 11, wherein:

the upper coil comprises a third coil and a fourth coil;

the third and fourth coils surround in a spiral form the back gap portion, and one of the third and fourth coils is fitted into the space between
10 coil turns of the other, insulated from the coil turns of the other, and the third and fourth coils are connected to each other so as to generate magnetic flux in the same direction and connected to the lower coil so as to generate magnetic flux in the same direction as the lower coil.

15 13. The magnetic recording/reproducing apparatus of claim 12, wherein the lower pole comprises:

a first lower pole film formed of the lower yoke;

a second lower pole film adjacent to the first lower pole film, having one surface flattened to the same level as the lower coil; and

20 the other lower pole films disposed in order adjacently to one another on the second lower pole film, and each of said other lower pole films having one surface flattened to the same level as an insulating film disposed in the vicinity of this film, and the uppermost film of said other lower pole films being adjacent to the gap film.

14. The magnetic recording/reproducing apparatus of claim 13,
wherein the lower pole comprises:

a third lower pole film adjacent to the second lower pole film; and
5 a fourth lower pole film adjacent to the third lower pole film, being
the uppermost film in the lower pole.

15. The magnetic recording/reproducing apparatus of claim 14,
wherein the upper pole comprises:

10 a plurality of upper pole films disposed in order adjacently to one
another on the gap film, and the uppermost film of said plurality of upper
pole films being adjacent to the upper yoke.

16. The magnetic recording/reproducing apparatus of claim 15,
15 wherein the upper pole comprises:

a first upper pole film adjacent to the gap film;
a second upper pole film adjacent to the first upper pole film; and
a third upper pole film adjacent to the second upper pole film.

20 17. The magnetic recording/reproducing apparatus of claim 16,
further comprising a coil-connecting conductor, wherein:

the coil-connecting conductor comprises:

a first connecting conductor film formed of the inner end of
the first coil and having one surface flattened to the same level as the first

coil, the second coil and the second lower pole film;

5 a second connecting conductor film made of the same material as the first connecting conductor film, disposed on said one surface of the first connecting conductor film and having one surface flattened to the same level as the third lower pole film that is adjacent to the second lower pole film;

a third connecting conductor film adjacent to the second connecting conductor film;

10 a fourth connecting conductor film adjacent to the third connecting conductor film;

a fifth connecting conductor film adjacent to the fourth connecting conductor film; and

a sixth connecting conductor film adjacent to the fourth connecting conductor film; and

15 the back gap portion comprises:

a first back gap film made of the same material as the second lower pole film, disposed on said one surface of the lower yoke and having one surface flattened to the same level as the first coil, the second coil and the second lower pole film;

20 a second back gap film made of the same material as the third lower pole film, disposed on the second back gap film and having one surface flattened to the same level as the third lower pole film;

a third back gap film adjacent to the second back gap film;

a fourth back gap film adjacent to the third back gap film;

a fifth back gap film adjacent to the fourth back gap film; and
a sixth back gap film adjacent to the fifth back gap film.

18. The magnetic recording/reproducing apparatus of claim 17,
5 wherein:

the third lower pole film, the second connecting conductor film and
the second back gap film have surfaces flattened to the same level;

the fourth lower pole film, the third connecting conductor film and
the third back gap film have surfaces flattened to the same level;

10 the first upper pole film, the fourth connecting conductor film and
the fourth back gap film have surfaces flattened to the same level;

the second upper pole film, the fifth connecting conductor film and
the fifth back gap film have surfaces flattened to the same level;

15 the third upper pole film, the sixth connecting conductor film and the
sixth back gap film have surfaces flattened to the same level as the top
surfaces of the third and fourth coils;

the upper yoke has one end adjacent to the third upper pole film and
the other end adjacent to the sixth back gap film.

20 19. A method for manufacturing a thin film magnetic head
comprising a write element, comprising the steps of:

forming a lower pole, a lower coil, a back gap portion, and a coil-
connecting conductor on one surface of a lower yoke so that the lower coil
surrounds in a spiral form the back gap portion, arranged within the height

of the lower pole in relation to said one surface of the lower yoke, and one end of the lower coil is formed of a first connecting conductor film of the coil-connecting conductor;

5 forming an insulating film covering the lower coil, and a gap film adjacent to the lower pole;

forming an upper coil on the insulating film, and an upper pole on the gap film so that the upper coil is disposed above the lower coil, arranged within the height of the upper pole, and the upper coil surrounds in a spiral form the back gap portion and is connected to the lower coil by
10 the coil-connecting conductor; and

forming an upper yoke so that the upper yoke connects the upper pole and the back gap portion.

20. The manufacturing method of claim 19, wherein the step of
15 forming the lower coil includes the steps of:

forming a first coil in a spiral form; and

forming a second coil so that the second coil is fitted into the space between coil turns of the first coil, insulated from the coil turns of the first coil and is connected to the first coil so as to generate magnetic flux in the
20 same direction as the first coil.

21. The manufacturing method of claim 20, wherein the step of forming the upper coil includes the steps of:

forming a third coil in a spiral form; and

forming a fourth coil so that the fourth coil is fitted into the space between coil turns of the third coil, insulated from the coil turns of the third coil and is connected to the first, second and third coils so as to generate magnetic flux in the same direction as the first, second and third coils.

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22. The manufacturing method of claim 21, comprising the steps of:

forming the lower coil, a second lower pole film, a first back gap film and a first connecting conductor film on one surface of the lower yoke
10 which forms a first lower pole film;

flattening surfaces of the lower coil, the second lower pole film, the first back gap film and the first connecting conductor film; and

forming the gap film, the upper pole, the upper coil and the upper yoke after flattening surfaces of the lower coil, the second lower pole film,
15 the first back gap film and the first connecting conductor film.

23. The manufacturing method of claim 22, comprising the steps of:

flattening surfaces of the upper pole and the upper coil after forming
20 the gap film, the upper pole and the upper coil;

forming another insulating film on the flattened surface thus obtained;

forming the upper yoke on said another insulating film.